

Earthquakes in Indiana: Understanding Seismic Risk in the Hoosier State

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"We learn geology the morning after the earthquake."
- Ralph Waldo Emerson



Indiana Geological Survey
A research institute of Indiana University

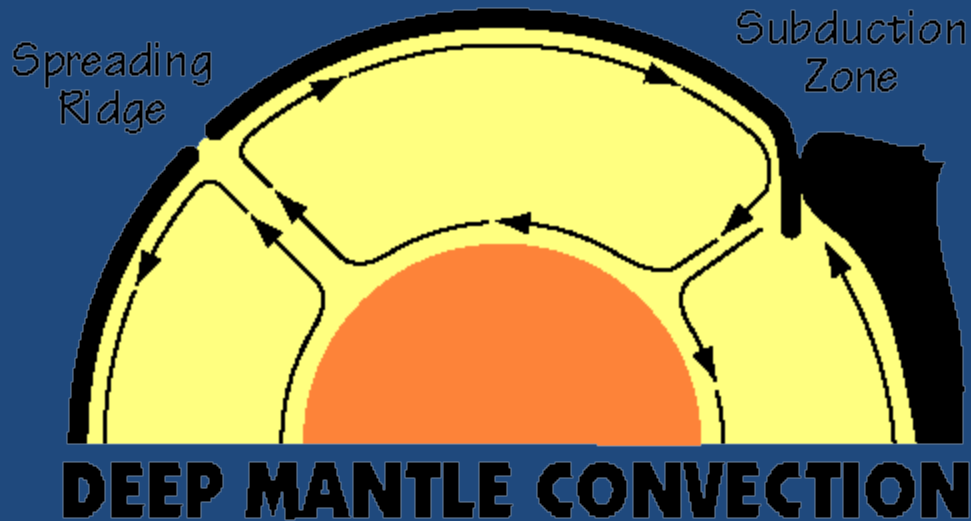




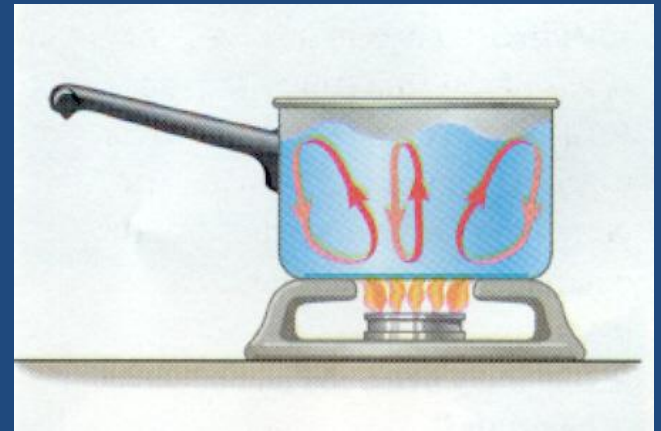
Plate Tectonics



Thermal Engine

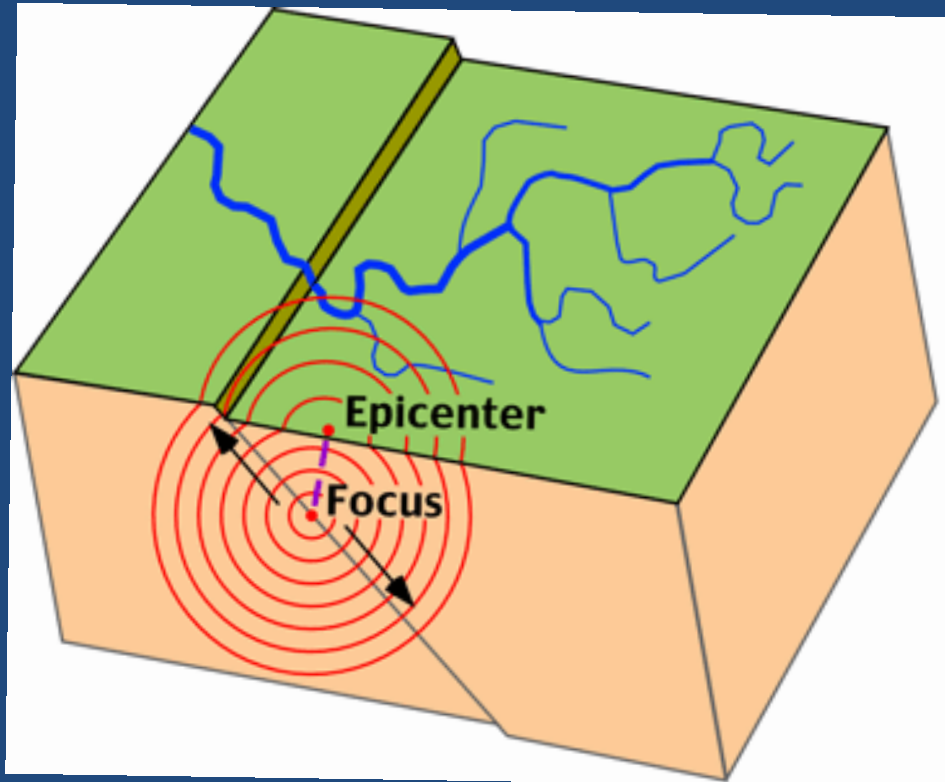


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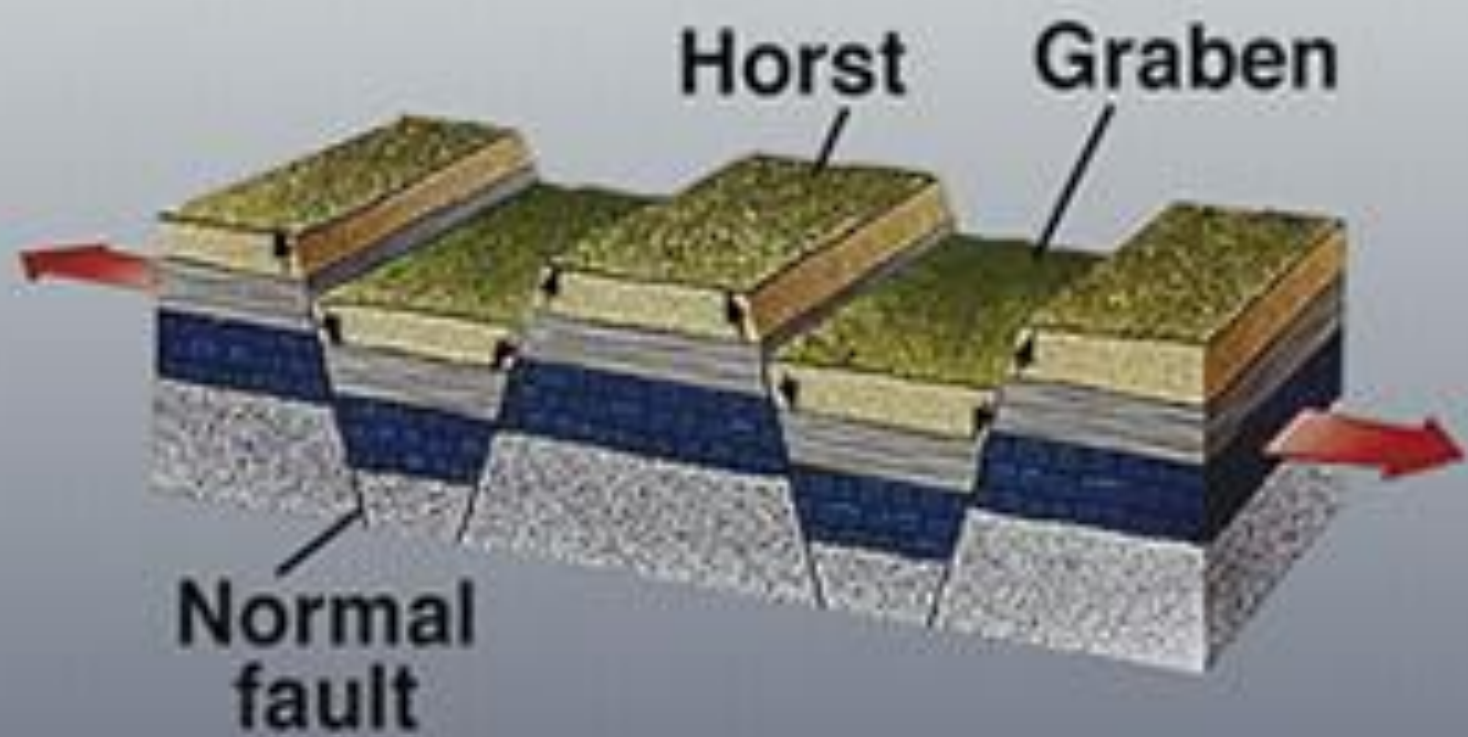


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Earthquake Mechanics



- Stress and strain build up due to plate motion
- Strain exceeds the strength of the rock
- The fault fails and the seismic energy released causes an earthquake

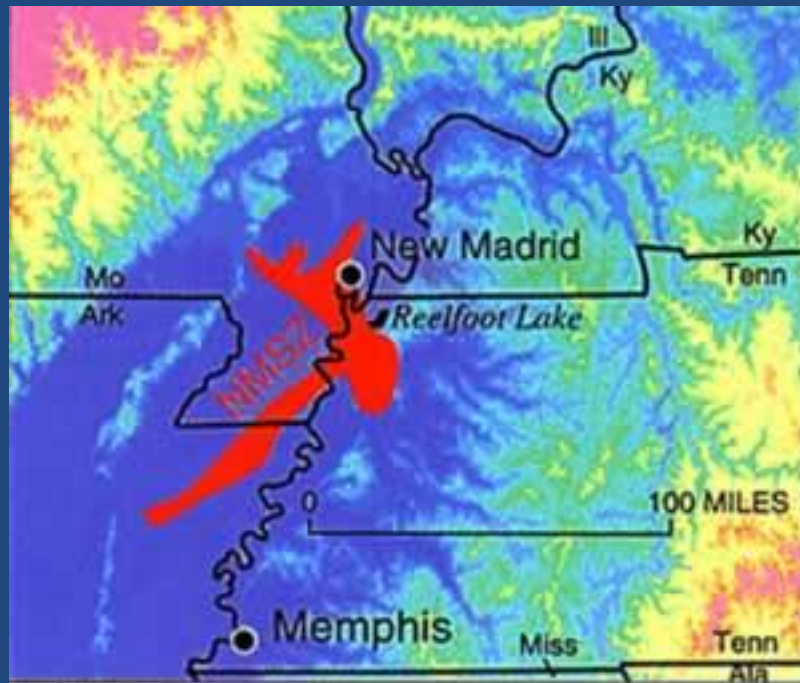


But What About the Midwest?



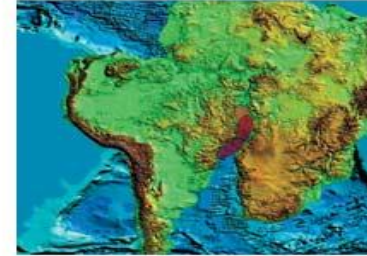
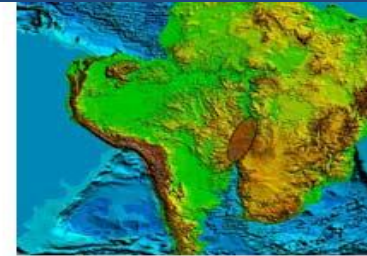
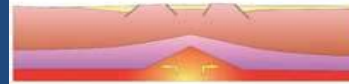
Rift Zones

Success vs. Failure

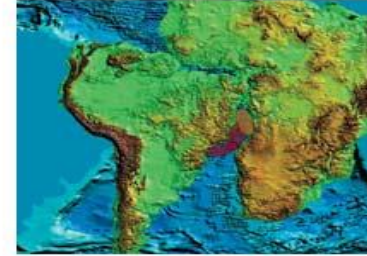
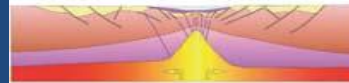


Rendering of the most active part of the New Madrid Seismic Zone. Source: <http://www.emporia.edu/earthsci/student/salley3/nmsz.jpg>; accessed February 12, 2006.

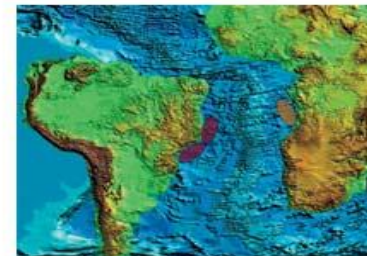
Rift phase - 130 to 115 Ma



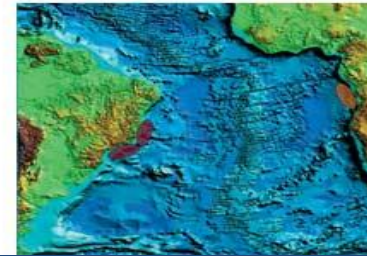
Transitional phase - 115 to 112 Ma



Early post-rift phase - 100 Ma



Late post-rift phase to Recent



Creation of the New Madrid Fault Zone

750 mya continental
rifting failed

200 mya restarted
but failed again

Present day strike-slip
regime

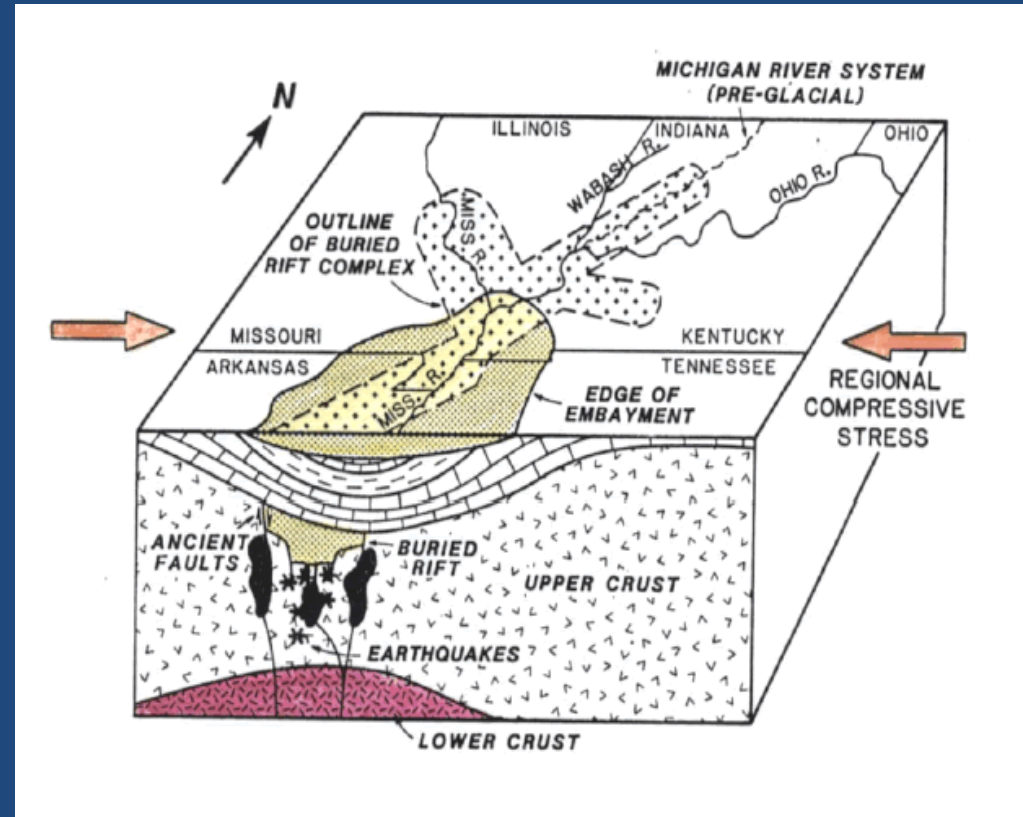
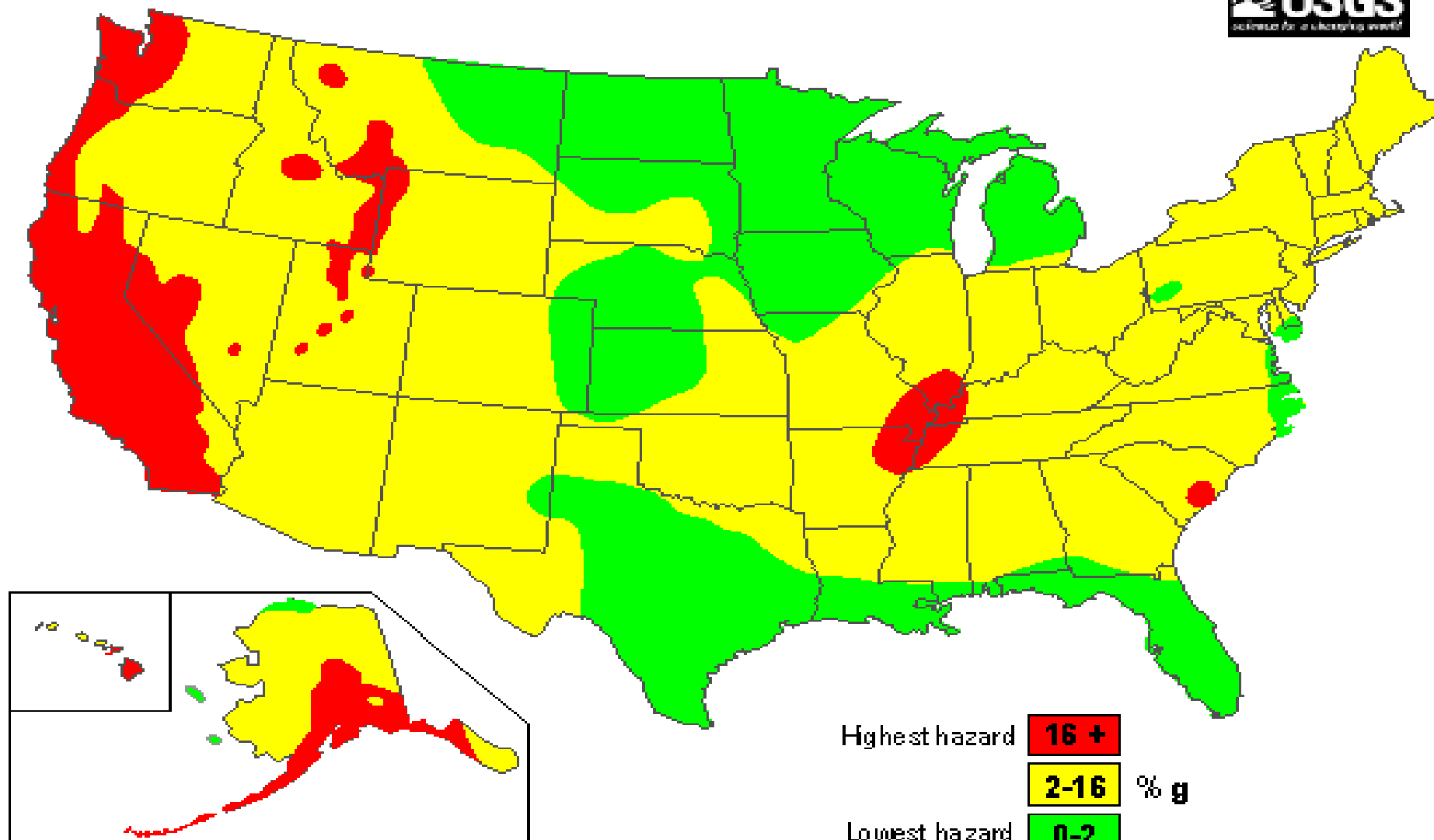


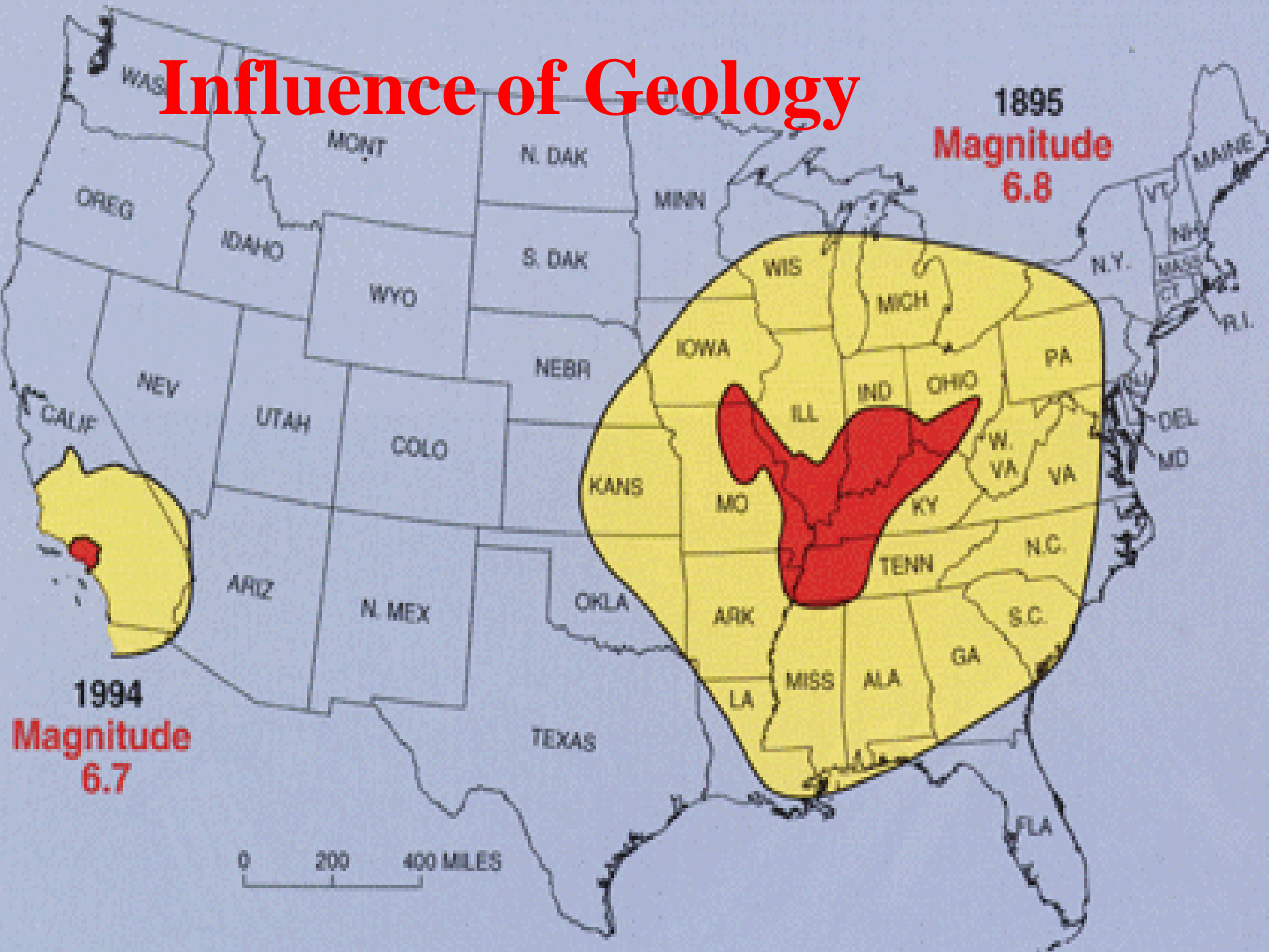
Figure 3.

National Seismic Hazard Map

Adapted from http://earthquake.usgs.gov/research/hazmaps/products_data/48_States/index.php



Influence of Geology



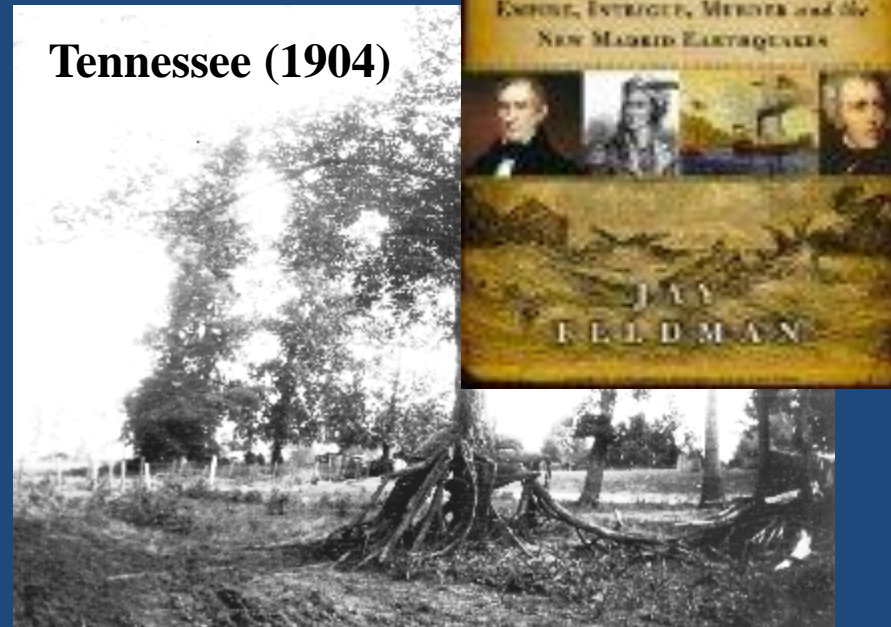
Timing is Everything

- Population of the Mississippi River Valley approximately 4000
- December 6th, 1811 (M 7.7)
 - 1 to 3 minutes of shaking
 - Felt as far east as NYC
 - Church bells rang in Boston, Mass.
 - Several structures destroyed
 - Water and sand ejected over 10 feet into the air (liquefaction)
- January 23rd, 1812 (M 7.5)
- February 7th, 1812 (M 7.7)
 - Destroyed the town of New Madrid
 - Reelfoot Lake created

•USGS Data



Tennessee (1904)



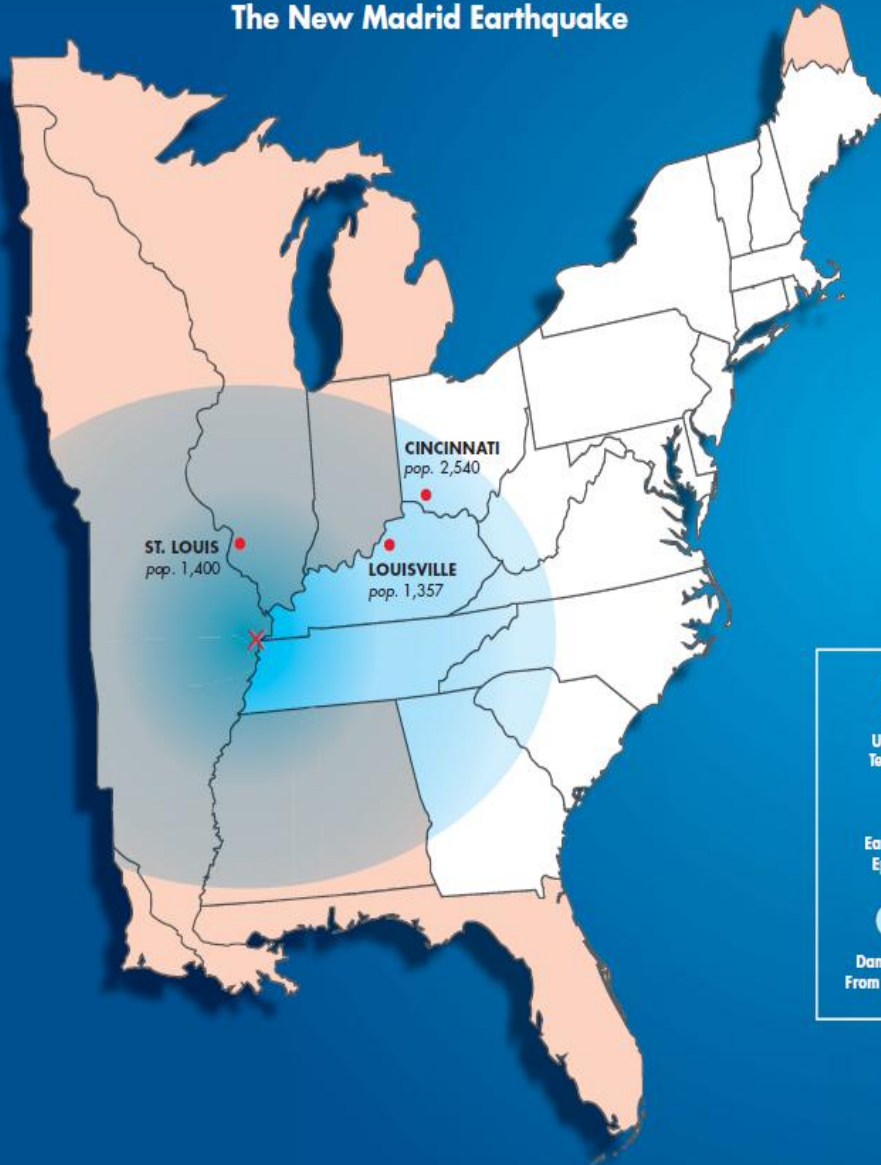


Birth of Reelfoot Lake, Tennessee



New Madrid Fault Area

America, 1811
The New Madrid Earthquake

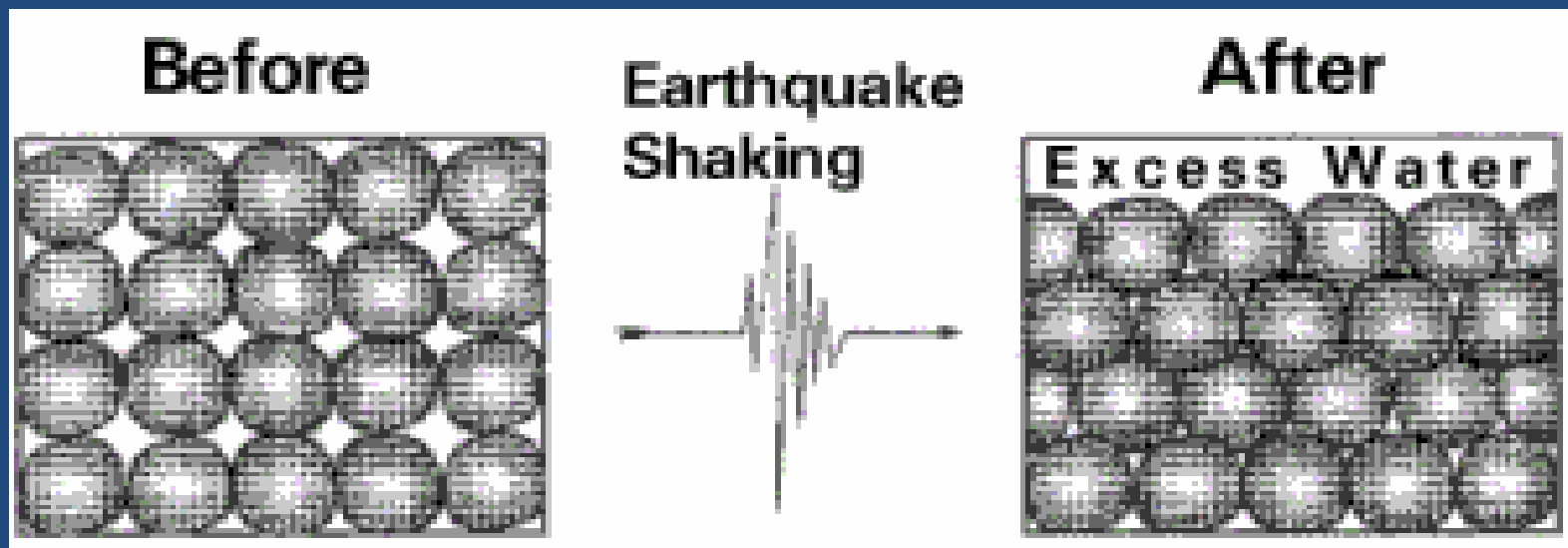


America, 2006
If It Happened Today

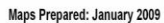


Historically active fault zone,
consistent bedrock, now what.....

<http://www.youtube.com/watch?v=ngxG49Lf6co&feature=channel>



- River valleys
- Unconsolidated sediment
- Water-saturated



Sand Blows

Indications of past and present soil responses to seismic events.



Recent sand blows dot the landscape surrounding New Madrid, MO,

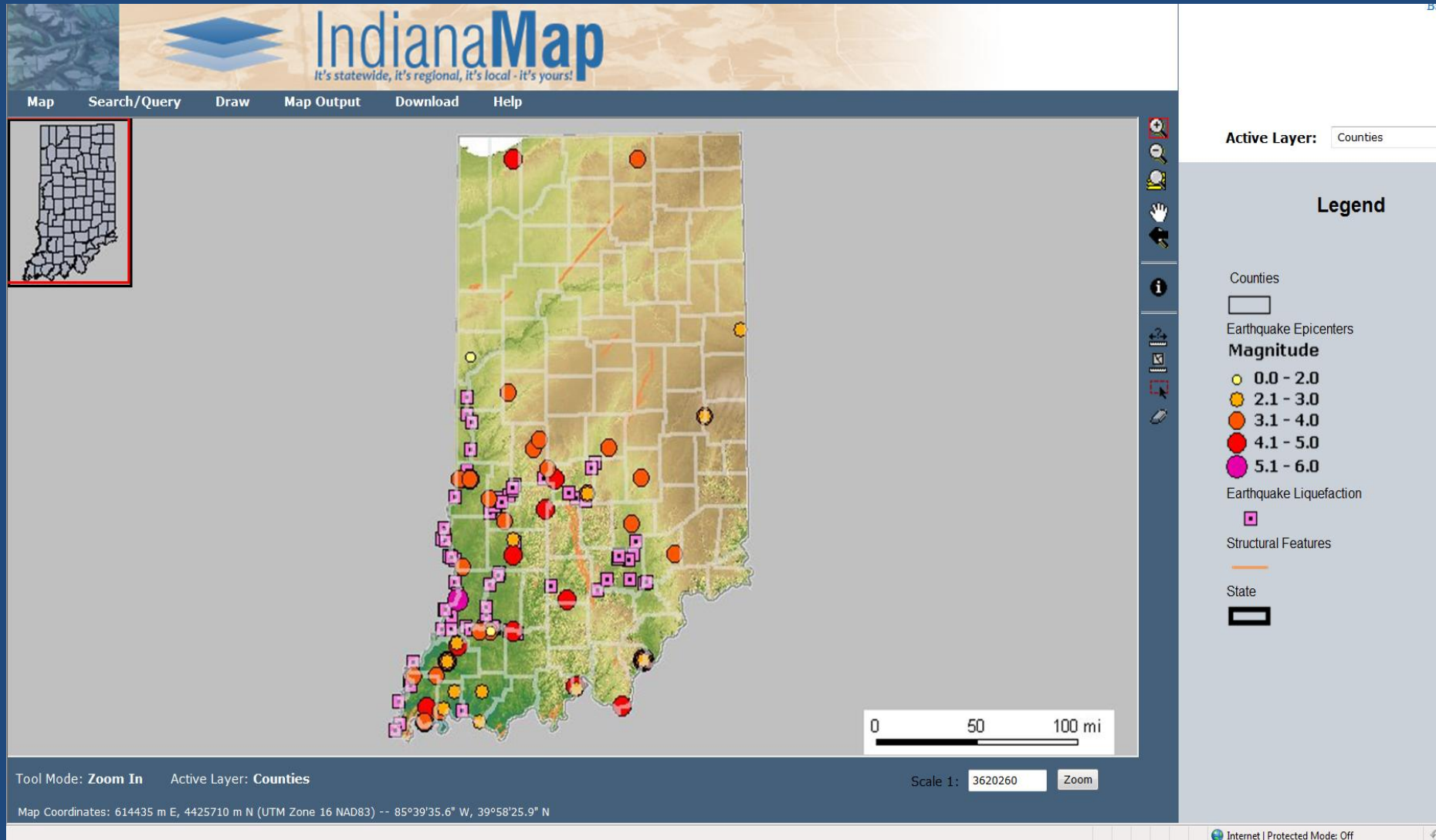


Liquefaction

The Response of Unconsolidated Soil During A Seismic Event



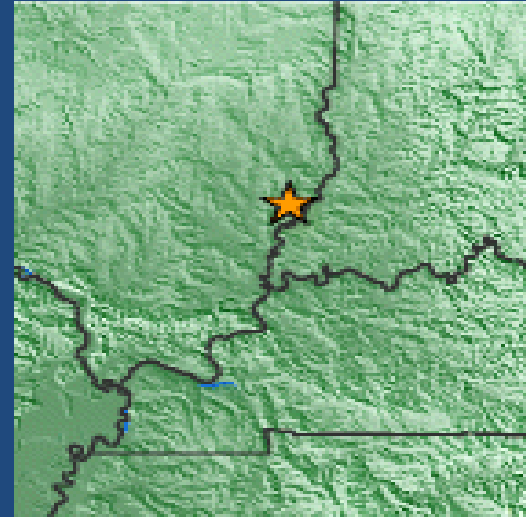
Known Liquefaction Sites in Indiana



Mount Carmel Earthquake (M 5.4)

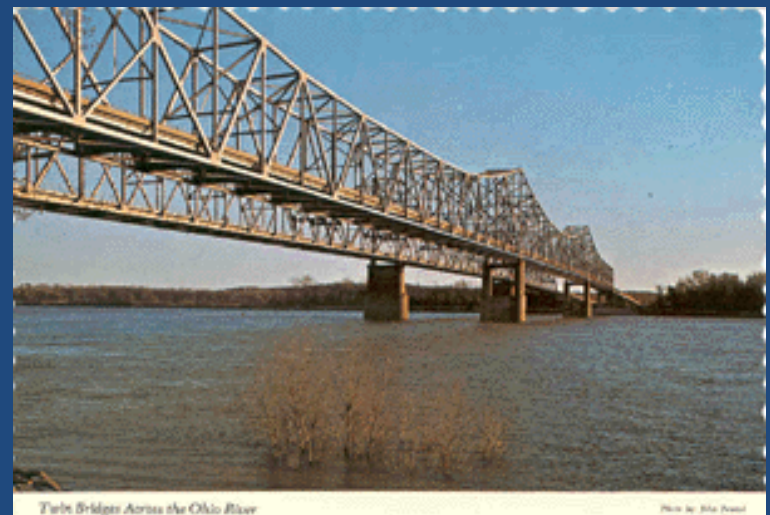
April 18th, 2008

Seismic zones



Magnitude 5.5 or greater is required for liquefaction to occur.

Emergency Planning Considerations



Official Participant

Join Us for the Largest Earthquake Drill in Central U.S. History.



April 19, 2011 10:15AM

Register at www.ShakeOut.org/centralus

Designed by Art Center College of Design

The Great Central U.S.
Shake Out

Welcome to the Great Central U.S. ShakeOut

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GET READY TO SHAKEOUT!

[Register](#) now for the 2011 ShakeOut on April 28 at 10:15 a.m.!

[Participate](#) in the Great Central U.S. ShakeOut to practice [how to protect yourself](#) during earthquakes, and to get prepared.

Learn [how](#) to participate below.

**Indiana will ShakeOut on April 19. Also, you can hold your drill at another time or day if best for your schedule.*

Time to 2011 ShakeOut:
6 months, 6 days 16:28:56

PARTICIPANTS

[Who is Participating?](#)

[ShakeOut Resources:](#)
ShakeOut Drill Manuals, flyers, movies, and much more

[Why Drop, Cover, and Hold On?](#)

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INTERACTIVE MAP

LEARN & PLAY

[How to Drop, Cover, and Hold On](#)

Coming soon...

Drill Manuals

These manuals are being adapted from the California ShakeOut for the Central U.S., but the general guidance will be the same. You can use these to begin planning your drill and return later to download the updated versions.

[ShakeOut Drill Manual for K-12 Schools](#)
[ShakeOut Drill Manual for Businesses](#)
[ShakeOut Drill Manual for Non Profits and Other Organizations](#)
[ShakeOut Drill Manual for Government Agencies and Facilities](#)

Multimedia

[Audio and Video "Drill Broadcast" recordings](#) created to provide instructions during your Drop, Cover, Hold On drill. These will soon be updated for the Central U.S. ShakeOut but you can listen to the California version to learn what will be available. The new version will be approximately one minute long.

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“Civilization exists by
geological consent, subject
to change without notice.”
-Will Durant



Indiana Geological Survey
A research institute of Indiana University

